I. C. 6731 June, 1933

DEPARTMENT OF COMMERCE

UNITED STATES BUREAU OF MINES
SCOTT TURNER, DIRECTOR

INFORMATION CIRCULAR

ACCIDENT PREVENTION AT THE NEW BLACK DIAMOND COAL MINE, WASHINGTON

RECEIVED
JUL 21 19
O. S. U. LIBRARY

BY

OHIO STATE
UNIVERSITY LIBRARY

S. H. ASH AND R. W. SMITH

I.C. 6731
June, 1933.

INFORMATION CIRCULAR

DEPARTMENT OF COMMERCE - BUREAU OF MINES

ACCIDENT PREVENTION AT THE NEW BLACK DIAMOND COAL MINE, WASHINGTON[1]

By S. H. Ash[2] and R. W. Smith[3]

Marked progress in safety has characterized the operation of coal mines in general in the State of Washington during the 5-year period 1928-1932, particularly during the years 1931 and 1932. Physical conditions[4] such as steep pitches, inherently bad roof and floor, prevalence of gas, and explosibility of the dust of Washington coals present certain definite hazards. Although advances have been made in accident reduction in Washington, the State still has far to go in that direction.

The State has endeavored to reduce its coal-mine accidents by the usual method of making certain definite safety requirements mandatory. The value of education has not been underrated, but the educational method used has not altogether achieved the results desired by the industry itself, particularly within certain individual organizations. The past 2 years have witnessed a growth, in certain instances, of the essential ideas that the observance of safety precautions on the part of all is demanded if accidents are to be reduced, and that the initiating and carrying out of any program to promote and obtain desired results in accident elimination must begin and function from the top downward. Mining operations of Washington mines have been described in various publications[5] of the United States Bureau of Mines.

---

[1] The Bureau of Mines will welcome the reprinting of this paper, provided the following footnote acknowledgment is used: "Reprinted from U. S. Bureau of Mines Information Circular 6731."

[2] District engineer, safety division, U. S. Bureau of Mines, Berkeley, Calif.

[3] Chief engineer, Pacific Coast Coal Co., Seattle, Wash.

[4] Ash, S. H., Accident Experience and Cost of Accidents at Washington Coal Mines: Inf. Circ. 6529, Bureau of Mines, 1931, 17 pp.

[5] (a) Evans, G. W., Coal-Mining Problems in the State of Washington: Bull. 190, Bureau of Mines, 1924, 79 pp.
(b) U. S. Bureau of Mines, Analyses of Washington Coals: Tech. Paper 491, 1931, 203 pp.
(c) Ash, S. H., Explosions in Washington Coal Mines: Tech. Paper 507, Bureau of Mines, 1931, 52 pp.

725543

PURPOSE OF REPORT

The purpose of this report is to show what has been accomplished in one more instance where the management decided that avoidable accidents must stop and that essentially all accidents are avoidable. It describes the results of accident-prevention work and how it is being accomplished at the mines of the Pacific Coast Coal Co. Because of the relative size of the mine and the effect that its accident experience has unquestionably had on the State as a whole, this report covers primarily the safety accomplishments at the New Black Diamond mine of the Pacific Coast Co. for the period 1927-1932.

GENERAL INFORMATION

The New Black Diamond mine is in King County, Wash., in the Cedar River Valley, 6 miles east of Renton and 18 miles southeast of Seattle, on the Renton-Maple Valley highway and on the main line of the Pacific Coast Railway and the Chicago, Milwaukee, St. Paul & Pacific Railway. The mine lies in the Indian-Cedar Mountain field, which is so closely related to the Renton field that the two are usually grouped together. This joint coal area occurs in the western part of King County near the northern end of the belt of coal fields which extends in a north-south line through Lewis, Pierce, and King Counties.

The mine is openod by a 4,400-foot, 0.75-percent grade tunnel driven from Cedar River Valley, at a portal altitude of 212 feet above sea level. This tunnel is timbered for its entire length; for a distance of 1,450 feet it was driven by forepoling through gravel heavily saturated with water, which at the time almost stopped operations, but later drained off. The remainder of this tunnel, although in sandstone and sandy shale, is timbered for a length of 2,950 feet. The Jones bed was cut here, and the main slope was located about 850 feet from the intersection. The tunnel averages 96 square feet in cross section inside of timbers, which are three-piece sets of 12- by 12-inch material, heavily lagged in the gravel area; it affords water-level drainage and a direct haulageway from the first level slope landing to the washing plant. The track is laid with 56-pound steel and is ballasted. The tunnel serves as the principal intake for the mine air.

The slope, which is holed to the surface above the water level at an altitude of about 600 feet, is sunk on the Jones bed to the third level. The slope is timbered 6 feet in the clear between the rail and collars, and 8 feet in the clear between the plumb posts or legs set at right angles to the roof.

The controlling grade between the top and the third level is 33° for about 210 feet between the second and third levels. The average grade is about 29°. The faults that cross the slope limit the maximum grade to 33°.

The water level, called the first level, measured on the pitch of the slope, is 673 feet from the slope portal; and the second and third levels are 1,215 and 1,728 feet, respectively, from the slope portal.

Three beds have been opened in the course of development. The beds known to be on the property, in the order of their sequence, are the Jones, the most important and the underlying bed; the Discovery, 150 feet stratigraphically above; the Cedar Mountain No. 2, 700 feet stratigraphically above the Jones, but not cut in the present mine; and the Cedar Mountain No. 1, which lies stratigraphically about 1,200 feet above the Jones.

Of particular interest in a safety discussion is the explosibility of the coal-dust from the beds being mined. Analyses[6] of the foregoing coal beds have been made. From the analyses the volatile ratio averages above 0.45, which is high, and is an index of the high explosibility of these coals; this fact is recognized by the management of the Pacific Coast Coal Co., by whom a thorough rock-dusting program is systematically carried out.

All coal is prepared by hand picking for the lump sizes, and all other sizes are washed in a Rheolaveur plant of two units. The plant reject is approximately 16 percent.

In 1930, the mine produced 320,345 tons, or 14 percent of the State total. During the 6-year period 1927-1932 the output was 1,506,543 tons, equivalent to 11.2 percent of that of the State. An average of 255 men employed underground and of 82 employed on the surface worked 2,752,928 and 892,072 man-hours, respectively. The coal mined per man-day was nearly 4.4 tons for underground men and was 3.3 tons for all employees. The State average was 3.52 tons for the period.

SURFACE PLANT AND EQUIPMENT

Coal preparation requires a more than average amount of surface equipment and personnel at the Western Washington mines; approximately 23 percent of the man-hours of exposure at the New Black Diamond mine are charged to surface operations.

The tipple, washery, and storage bins are situated about 700 feet from the mine portal and are reached by a practically level trestle. The tipple is a wooden-frame building with galvanized-iron covering; attached to it as part of the structure are large wooden bins of slow-burning material. Fire protection in the tipple and other surface buildings consists of Pyrene-type fire extinguishers placed at several points and hydrants with hose. Water tanks and several hose houses with hydrants are placed advantageously about the tipple yard, and inspection cards are displayed in these hose houses to show that the hose is in good condition. Fire drills are also held. The electric wiring is in conduit, 440 volts a.c. being used for motors and 110 volts for lighting. Pyrene extinguishers and pails of sand are well distributed about the electrical equipment. The transformers are installed in a wire-fenced area which is kept locked. Smoking is not permitted in and about the washery. Frequent systematic washing down keeps the dust at a minimum. The machinery in general is exceptionally well guarded.

---

[6] See footnote 5b.

The surface engine house, located at the top of the Jones slope, is a wooden-frame building covered with galvanized iron.

The main hoist is electrically driven. An engineer is on duty at all times, who looks after the main ventilating fan in addition to his other duties. The hoist has a rope speed of 700 feet per minute and is driven by two 200-hp., a.c., slip-ring motors with efficient controls. In hoisting, three cars weighing 17 tons make the trip; the hoisting cable is of $1\frac{1}{4}$-inch plough steel and the car couplings are of $1\frac{1}{4}$-inch stock. The hoisting cable is inspected daily and a record is kept of its condition. The rope is removed when upon inspection it is found to be unsafe, as shown by broken wires.

A low-pressure, hand-fired boiler furnishes hot water for the washhouse. The attendant in charge of the washhouse also looks after the boiler. Steam is used at the mine only for heating and for cold-weather service around the washery.

Electric power is purchased. The power is delivered at the mine at 13,000 volts and is stepped down to 2,200 volts at a bank of transformers which consists of three 250-kv.-a. units; some power is utilized at 2,200 volts; but to give lower voltages other 2,200- to 440-volt transformers are provided. The hoist is on a separate line which is connected direct to the 13,000-volt line.

The d.c. system is all 250 volts and is generated by a motor-generator set at the plant. The a.c. side is a synchronous motor rated at 731 kw. using 2,200 volts, while the d.c. side is rated at 1,090 amperes at 250 volts. There are no haulage feed lines in the mine on the d.c. side other than the trolley line of 0000 wire. The entire track system is electric-bonded with bonds of ample capacity. Both rails are bonded in the main haulageway and one rail in the gangways.

A telephone system is efficiently maintained both on the surface and at the slope landings. The hoisting signals are clear and distinctly given. The open-type bell wires operate on 20-volt alternating current and are hung in the slope.

UNDERGROUND EQUIPMENT AND HAULAGE

Mine haulage is by rope and trolley locomotives. Sheet-iron chutes are used on the pitch and the mine cars are loaded on the gangways.

The rails on the main slope and haulage tunnel are of 56-pound steel and those on the gangways of 40-pound steel. The track gage is 36 inches and the maximum grade allowable on the gangways is 0.75 percent. Due to the easy running of the Timken-bearing mine cars, however, difficulty has been experienced in braking the trips, and the gangway grade is held, if at all possible, to 0.5 percent.

The main haulage motor for the outside haulage of coal from the Jones slope to the tipple is a 250-volt, 12-ton Westinghouse locomotive of the outside-wheel type equipped with air brakes. It makes a run of 10,200 feet per round trip, hauls 40 or 50 cars per trip, and moves from 480 to 500 cars per 8-hour day. Smaller locomotives are used on the various gangways.

Mine cars are of wood and steel construction with solid ends and without brakes. Each car has a capacity of 122 cubic feet, holds approximately 3 tons of recoverable coal, and when empty weighs 3,889 pounds. The dimensions are 13 feet 1 inch long, 4 feet 7¼ inches wide, and 4 feet 3 inches high over-all. Sixteen-inch diameter wheels are set on a 4-foot wheelbase and are equipped with Timken roller bearings using grease.

The type of car and character of loading does not permit topping, and any spillage of coal on the roadways is due to the coal's piling up on one side while being loaded from the chutes. The coal, with the exception of the gangway faces, is dry and has a tendency in some localities on the pitch to make considerable fine dust, which tends to accumulate in the pitch workings above the counter.

Pumping is relatively not a serious problem, as the water to be removed probably averages only about 250 gallons per minute throughout the year. For this purpose electrically-driven, induction, a.c. pump units are installed in separate splits of intake air. Compressed-air pumps are used for sinking or where there is likely to be an explosion hazard.

Manways and Man-Trips

The mine is provided with good manways in the slope return air course, and in addition separate fresh-air, main-intake traveling ways are provided. Manways with ladders are provided in all chutes on the pitch.

Man-trips are furnished for the travel of the men into and out of the slope, as well as out of the main water level to the surface. On the slope, safety man-cars of the Klansnic type are handled in 4-car trips and carry 10 men to the car. Regular mine cars are used on the water level behind the trolley locomotive, and no one is permitted to ride loaded trips.

UNDERGROUND MINING CONDITIONS AND METHODS

Characteristics of Jones Bed

Because most of the experience discussed in this report was developed in the Jones bed, its characteristics are given. This bed is worked for its full thickness of 7 to 8 feet. It has a strong shale roof which contains numerous coal streaks. On account of its shelly nature about 2 inches of the rock lying next to the coal comes down with the mined coal; this cannot be prevented, but is not a dangerous factor in a cap rock. The dip of the beds averages 30°, increasing to the south and west up to about 40°; the dip permits the use of sheet-iron chutes, and the coal runs well. The bottom is banded and bony; it heaves in the pillar operations, breaking the props, but usually gives advance warning. Numerous small faults run essentially parallel to each other through the bed, but there is little or no cross faulting and the roof stands up well. The faults tend to relieve pressure on the pillars, thus making it necessary either to mine the coal or blast it off the solid. Niggerheads are found in this bed and usually occur in the lower bench or in the interval between the two benches; they are generally small, and stand almost vertical, resembling stumps of old tree trunks.

Plan of Underground Development

Levels are spaced 550 feet apart, measured from high to low rib of levels. Auxiliary slopes are used below the main levels when sinking is done. The main slope has a single track; the turnouts are made on a 100-foot radius, and the main partings hold 40 cars. During sinking operations, water is handled by means of a compressed-air pump kept within working distance of the face.

Two air courses, one on each side of the slope and parallel to it, serve as main returns and can also be used for manways; they are about 10 feet wide, the height of the bed, and are timbered with chute sets of 7-inch round timbers. The slope pillars are about 110 feet wide and are solid between the main slope and the airways. The main airways are holed to the surface near the slope mouth, and the mine fan is located at the mouth of one of them.

Method of Mining

The method of mining is known as the "compartment chute-and-pillar system" and is described in detail in various publications.[7]

Whether the coal is undercut, overcut, or sheared depends largely on the location in the mine; at the present time cutting is done by pick. In Washington mining practice, blasting off the solid in advance work is broadly construed to mean blasting where there is only one free face; and in pillar work, where the solid coal intervening between any free face and the back of the hole is in excess of 6 feet. The tendency is to depend upon the judgment of the supervisor as to whether or not a shot is "dependent"; this leaves room for an entirely too liberal interpretation, and it would be better to have a fairly rigid rule and adhere to it. Next to open lights, blasting is the most frequent cause of Washington's mine explosions[8] and accounts for 30 percent of the total when open lights are included. Mine operators should be encouraged to develop systems of mining whereby the coal can be economically and properly cut or sheared with safe equipment, rather than prohibited by inflexible regulations from introducing efficient systems to promote safer mining and to meet competition. To prepare the faces for safe blasting by pick mining on heavy pitches is highly dangerous and cannot be done in many instances because of numerous dangerous factors, including that of falling and sliding material; solid shooting is eventually resorted to, with its innumerable dangers and inefficiencies.

---

[7] See footnote 5a.
See footnote 5b.
Ash, S. H., Prevention of Accidents from Falls of Roof: Proc. Rocky Mountain Coal Min. Inst., 1930, pp. 39-43.

[8] See footnote 5c.

In the past, air-driven machines of the post-puncher type were largely used[9] at some mines of the Pacific Coast Coal Co., including the New Black Diamond mine, as well as in other regions having pitching coal beds, but they were not satisfactory or economical. When this equipment was discontinued at the New Black Diamond, it practically disappeared in that mining region. Eighteen Sullivan post-punchers were in use at one time in this mine. Where these machines were installed two men were employed to give instructions at the face in the use and care of the machines. The machines were compressed-air driven, and as designed at that time required about 250 cubic feet of free air per minute; a new machine requires only 150 to 200 cubic feet per minute.

On the water level, longwall machines were tried, and, so far as the machines were concerned, they worked satisfactorily. Unsatisfactory layout of the longwall face and difficulties with an unsatisfactory conveyor installation led to the abandonment of this type of chain machine.

Recent developments in the Roslyn field have clearly demonstrated that shortwall chain machines with present-day conveyors can be worked on pitches steeper than 45° more successfully than has been approximated by hand methods. When using conveyors, the pitch is an advantage instead of a disadvantage.

Timbering

Systematic timbering rules are strictly enforced. The pitch workings are timbered systematically with props and stringers in all parts of the mine; the gangways are timbered with sets placed on 6 to 8-foot centers. In the pillars, single-stick timbering only is required, props being set 4 feet apart, with 6-foot lagging for cap pieces. The props are of split timber, 8 feet long, and average 7 inches in diameter.

---

[9] Ash, S. H., Systems of Coal Mining in Washington: Trans. Am. Inst. Min. and Met. Eng., vol. 72, 1925, pp. 833-873.

Timber and Material Distribution

The method of timber distribution employed is one of the major causes of the excellent performance of the pitch miners in this mine as compared with the average for the district. The fact that plenty of material with which to work is kept readily available at the face is in itself conducive to safer working conditions at the face, where most accidents occur. During the day, or on idle days, timber is loaded in mine cars outside and brought into the mine; it is then taken to the working places either on the afternoon shift, if working full time, or at any rate in such manner as not to obstruct the face worker. This practice also applies to the handling of sheet iron, pipe, and other supplies.

The distribution system, in addition to providing plenty of timber and supplies, has materially lowered the cost of such items as compared with the old method in which men "packed" all timber and supplies. Timber "packers" still distribute some of the material on the pitch, but the bulk of the material used in advancing the chutes and in mining the pillars is moved direct from the gangway to the face of each chute or pillar.

The timbers used in chute construction, and the sheet iron and air pipes are heavy and bulky. To facilitate handling of these supplies a track is carried in the manway side of every chute. This is made of 2- by 4-inch lumber nailed over 1- by 6-inch boards to form two troughs which are used for rails. These are nailed ladder fashion over 2- by 4-inch rungs, which serve as ties as well as for the ladder. The car is 24-inch gage and is equipped with flat wheels to run in the trough rails. A truck is placed in each chute manway, and a 3/8-inch cable is attached. Extra cable for advance is made into a roll and hung on the gangway. A bull wheel is attached to the last wing near the face. Two small portable electric hoists having a drum to which the cables can be attached or removed, are used to hoist the material up the chute; the hoists are small and easily moved from chute to chute on the gangway by means of a trolley locomotive.

During the shift while the miners are at work the fire boss or shot firer takes an order for their supplies. This order is handed to the timber hoistman, if one is employed, who attends to the delivery of this material on the afternoon shift, when no coal is handled except to load all empty cars then in the mine. An extra supply of timber and pitch supplies is kept on the gangway to prevent delay on the part of the timber distributors in getting the timber to the faces during their shift. The principal feature of the distribution method consists of the track and truck in every chute, a method that eliminates the passage of timber through the crosscuts. The timber is hoisted to the last wing placed by the miner and is then carried to the face by the miner, on the basis of his contract; for this reason it is advisable for the miner to keep the wing and bull wheel as near as possible to the face. The wings are advanced each time the chute advances 20 feet.

EXPLOSIVES

Permissible explosive is used exclusively at the New Black Diamond mine for the coal, and gelatin dynamites are used in rock work. Data covering normal operations and development indicate the following averages for explosives consumption per ton of coal: Tamping bags, 0.73; blasting caps, 0.314; fuse, 1.985 feet; dynamite, 0.019 pound; and permissible explosive, 0.422 pound.

Explosives are distributed in an excellent manner and detonators are handled separately by certified shot firers who inspect and blast all shots at regular shooting times when the men are in the mine.

An examination of the working place is made by the shot firer immediately before he lights any shots. The method of lighting the fuse by means of touch paper[10] or punk is probably peculiar to this region. This practice puts much responsibility in the hands of one person; hence, the most rigid discipline is practiced at this mine relative to testing for gas. That the system is carefully used is attested by the fact that there has never been an explosion at this mine.

A record is kept of missed shots, of which there are few; when they do occur it is obviously due to one or more of the numerous difficulties likely to be met in the use of fuse. In such instances the place is fenced off and no one is permitted to return until 8 hours have elapsed. No attempt is made to recover the explosive, and another hole is drilled to one side; care is exercised in cleaning up the broken coal to obtain the unexploded explosive.

There is much that can be said in favor of electric blasting and little against it, though it is by no means "foolproof." However, under existing mining methods on the steep pitches of western Washington, it has been found in some instances to be exceedingly dangerous to fire shots singly by electric blasting methods, following more than one to two shots. It is decidedly dangerous in such instances to return in succession to the face after each shot because of falling material and impaired ventilation.

Moreover, because no acceptable and adaptable cutting machine is now available unless post punchers are used, and they are by no means satisfactory, with the present mining methods which require working up the pitch, to blast a round of shots simultaneously with a face not properly cut or sheared would be very likely to cause blown-out shots. Without exception, Washington coal-dusts in suspension are dangerous as to possible ignition or as to propagation of an explosion. Moreover, there is no permissible blasting unit for multiple shot firing. Unquestionably, in many instances permissible mining machines could be utilized safely and efficiently on moderately steep pitches to avoid solid shooting; there is an honest difference of opinion as to the economic phases of methods of doing this, and there has been no practical demonstration of the feasibility of using such machines on the steeper pitches. Mines have been closed in western Washington because the coal could not be economically prepared for safe blasting practice, "electrical" or "fuse and cap", under gassy and dusty conditions. The blasting of shots when all men are out of the mine does not offer an entirely satisfactory solution for the reason that running ground is prevalent in some instances, though fortunately they are exceptional. Timbering in most cases must be extended soon after blasting; under some circumstances if it were not done the place would be lost. Fine material from the roof, slides from the floor, slabs from the roof, sloughing ribs, and niggerheads as well as other conditions make blasting an unusually dangerous practice in many Washington mines. Unquestionably, the factors involved in one way or another from blasting in this State as a whole offer the greatest disaster hazard to Washington miners.

---

[10] Parker, D. J., Touch Paper: Inf. Circ. 6067, Bureau of Mines, 1928, 2 pp.

The field is open for an adaptable permissible coal-cutting machine and permissible multiple-shot blasting units by which the coal can be properly undercut and the shots blasted simultaneously and more safely. Electric blasting from power circuits is highly dangerous on pitching high-volatile ratio coal beds unless the current control is such as not to ignite gas or the dangerous dust cloud inevitably set up by friable coals running down the pitch. However, electric blasting offers the safest way to prevent explosives accidents; and electric blasting, if properly done, offers the best safeguard against gas or dust ignitions from blasting practice; but unless due consideration and care are exercised, power blasting can prove to be far more dangerous than the use of fuse and detonators if an electric arc is present in a dangerous dust cloud, possibly containing varying amounts of methane. About 41 percent of the State's tonnage is obtained from mines using electric blasting by single-shot blasting units, - a method applicable where steep-pitch conditions are not found.

Drilling

All drilling in the mine is done by compressed-air drills supplied by the company, for which the miners furnish the steel. Each pair of miners is furnished with a drill. Drilling time is cut down considerably by this method in these particular beds, and the holes are better placed. Hand drilling was a slow method and it was difficult to secure the proper number and position of holes; one half day was the average time needed in hand drilling to place a round which now requires about 30 minutes. The use of compressed-air drills is one of the main causes contributing to better than normal or average performance of the miners in this mine. The holes are more likely to be properly placed so far as dependent shots are concerned and are drilled deep enough to allow the explosive to go to the back of the hole.

The only fatal accident that has occurred at this mine due to blasting was on December 7, 1925, when a premature explosion killed two men; this explosion was caused by a haulage motor's accidentally shorting the lead wires of primers made up for electric blasting.

VENTILATION

The New Black Diamond mine is classed as gassy and is worked exclusively with closed lights. It is ventilated by a continuously exhausting centrifugal fan. This is a Sirocco 14, double-inlet, reversible type and the fan duct is equipped with explosion doors. The fan is located on the surface near the slope portal and is connected with the main return.

Any falls in the main return and counters are cleaned up, and these passageways are kept in good condition because they are used for manways.

Permanent overcasts are in solid rock. Chute stoppings are of wood, and line brattices of wood and canvas convey the air from the last crosscut to the faces in the chutes.

The old workings are ventilated when not sealed off. The mine is kept free of standing gas, and no explosive gas is allowed to exist in the mine workings. The mine is examined for gas not longer than 2 hours prior to the time that the miner reaches the working place. Two fire bosses do this work and make their report before the men enter the mine. A record of such inspection is kept and the only time gas appears to be found is when a brattice gets too far behind. Unlocked flame safety lamps of the Wolf and Koehler type are used.

Permissible electric cap lamps of the Edison type are used exclusively for lighting by the workers. There have been no accidents from methane or from ignition of methane at this mine.

Although classed as a gassy mine the New Black Diamond is not as gassy as most deep mines in Washington. Analyses by the United States Bureau of Mines show about 2,500 cubic feet of methane per 24 hours being discharged at the main fan.

The U.C.C. methane indicator is frequently used to check the return air and ventilation maintained to keep the methane content below 0.2 percent under any conditions. Systematic sampling of the mine air is done and the samples are analyzed either by the Bureau of Mines or a thoroughly equipped laboratory maintained by the company.

ROCK-DUSTING

Moisture conditions throughout the mine as a whole, coupled with the explosibility of the fine coal-dust, justify serious consideration and effective methods of controlling what would be a dangerous explosion hazard. To protect against this danger effectively the mine is adequately rock-dusted in all accessible parts whether in a dry or even wet condition. Limestone-dust specified as satisfactory by the Bureau of Mines is used for this purpose. Rock-dust is applied and extended by hand as well as with a high-pressure M.S.A. rock-dusting machine. Systematic sampling is done to insure adequate rock-dusting.

ACCIDENT PREVENTION

First-Aid and Mine-Rescue Equipment

The mining company keeps first-aid material, including bandages, stretchers, splints, and blankets, at convenient points in and about the mine and has a doctor on duty at the New Black Diamond. An emergency hospital with attendants and ambulance service is maintained.

The company has a first-class rescue station at the mine equipped with 6 sets of Gibbs breathing apparatus, an oxygen pump, a large supply of regenerating material, oxygen, and other accessories; this equipment is kept in condition by a regular attendant and regular tests are made and reported by him. Six All-Service gas masks with adequate supplies are also kept at the station. Considerable numbers of men employed at the mines are trained in mine rescue methods and several are kept trained for emergencies. All persons employed underground provide themselves with self-rescuers, which are systematically handled and checked daily.

Welfare Work

The welfare work includes the maintenance of a mutual group insurance fund through a mine association to which all workmen belong and from which benefits are paid to the sick as well as the injured. The association is known as the Mutual Benefit Association, and is governed by rules promulgated and supervised through a committee of the mine council or workmen's organization. The monthly dues are $1.50.

Under the plan, if an employee is incapacitated through illness or injury he receives $1 per day for 150 days during any one yearly period, with the exception that for periods up to 30 days the first 7 days are exempt; but beyond this time the waiting period is retroactive.

In event of a fatal injury the beneficiary of the deceased workman receives an immediate cash settlement of $500; there has been only one fatality in 4 years.

This plan in no manner interferes with or shares in any industrial insurance system or any beneficial order to which the workmen can or may belong.

Unquestionably, such a plan tends to keep the workmen mutually concerned about the status of an injured employee, as well as the nature and cause of his injuries. It also engenders a sense of responsibility and desire to eliminate accidents, besides calling attention to those who for some cause or other are more or less frequently incapacitated.

Safety Organization

By virtue of their contacts and experience persons engaged in hazardous industries unquestionably should be competent to know the causes of accidents and also should be well aware of the misery that follows in their wake. There is probably no single endeavor that has brought to the minds of the individual how serious an injury can be and how necessary and possible it is to prevent occurrence of injuries than a well-grounded training in first aid. Experience indicates that plants keeping up first-aid training are eventually the plants that prove that accidents can be prevented. The principle of accident prevention by safe practices eventually wins when a procedure or accident-prevention policy is followed which is both educational and administrative.

At the mines of the Pacific Coast Coal Co. the educational program started in earnest about the close of the year 1928. The management then decided that every employee should be trained in first aid and that this status should be maintained; that the supervising force from the top down, including the medical staff, would be jointly responsible for accidents to men in their charge; that preventive measures should be enforced by seeing that safeguards were installed and efficiently kept; that each new man should be physically and mentally fit, provided with safety equipment that he must use, and should be taught the safe method of doing his work; and that men who were careless, unfit, or injured repeatedly, should be dismissed or shifted to work that they could perform safely.

There is probably no group of miners in the United States that are more familiar with recovery work involved in mine explosions, mine fires, and disastrous cave-ins than are the workmen in the Washington coal mines. As a fundamental training in the safe procedure to follow not only to prevent such disasters but also to handle them if they do occur, the supervising force and a large number of workmen at the mines of the company have been thoroughly grounded in (and from time to time review) the courses offered by the United States Bureau of Mines in advanced mine rescue and accident prevention in bituminous-coal mines.

The administrative program consists of an investigation of all accidents and a review of them by the management; a statistical analysis of current accidents; and the keeping of employment records showing entering and leaving service data, which are in substance histories of insurance carried by the

Digitized by Google Original from THE OHIO STATE UNIVERSITY

employee, previous employment history, previous accident record, accident and sickness history, and reasons for leaving service. Compulsory physical examination and medical service, reporting of accidents, following up compensation and medical-aid matters, the doctor's part on the job, and the complete history of claims are matters not only discussed with the supervisors but also reviewed in some part at monthly safety meetings of all employees. Current information circulars and pertinent literature of the Bureau of Mines are reviewed.

A safety committee required by State law[11] makes a bimonthly inspection of conditions affecting the safety and welfare of the men in and about the mine. This committee is composed of representatives of the employees chosen by the employees themselves, and the superintendent or some other official representing the company. This committee investigates and reports all serious or fatal accidents, the latter to the State Mine Inspector. The method of reporting accidents is prescribed by law, in that any person injured must report the nature and time of his injury to his immediate supervisor at the time of the accident.

A most effective method to keep supervisors on the alert as to what is expected of them is to let them know that the management is thoroughly informed of injuries which occur and that they expect accidents to be eliminated. To attain this end a monthly letter is addressed to each superintendent and a copy is given to each supervisor; this letter consists of a description of each accident that occurred during the month and places the responsibility. A statistical table shows a summary of accidents and severity for the month, year, and corresponding period of the year before, together with the name of the supervisor and the accident record of the district in his charge.

In the matter of protective clothing the Pacific Coast Coal Co. has set the pace by being the first to adopt compulsory head protection. A review of the number of eye injuries plainly indicates that the adoption of goggles will show results in the future. A unique system known as the "daily broadcast" is in effect; the men on congregating at the mine portal are told by means of a loud speaker connected with a microphone at the mine office of various phases of the safety of the mine, and their attention is called to current accidents and means of preventing their recurrence.

ACCIDENT EXPERIENCE

Because of the thoroughness of the statistics kept by the large individual mines and the unified compensation system throughout the State, a complete study of mine-accident occurrence is possible and is of value and importance in pointing the way to steps that should be taken to eliminate accidents.

---

[11] Ash, S. H., Safety Committees in the Coal Mines of the State of Washington: Inf. Circ. 6283, Bureau of Mines, 1931, 9 pp.

The last fatal accident occurred at the New Black Diamond mine on January 21, 1929. On that date a miner received injuries from which he died when the "wind" caused by a cave in a pillar hurled him violently against the rib of a crosscut into which he and his partner had gone.

Since that time and up to March 1, 1933, 1,116,262 net tons of coal have been produced and 2,435,616 man-hours of labor performed; this is an outstanding record in the coal-mining history of the steep pitches of Washington. In recognition of safety achievements, the Joseph A. Holmes Safety Association on March 6, 1933, awarded a certificate of honor to this mine.

To show the effect and trends of accidents and their relation to accident rates and industrial insurance costs, a number of tables and graphs were prepared, but lack of funds prevents their being shown. The scale of time losses for weighting deaths and permanent injuries to show the severity of accidents is the same as that used by the National Safety Competition.[12] Temporary disabilities include hernias and are weighted according to the actual number of calendar days of disability, including Sundays and holidays. For industrial insurance purposes Washington has an absolute 3-day waiting period.

The first outstanding fact noticed in an accident-prevention campaign is the elimination of noncompensable accidents and fatalities. The matter of eliminating permanent partial disabilities is a problem affected not only by accident occurrence but also by the increasing tendency in all jurisdictions throughout the country to consider accidents as belonging to this class to an increasing degree.

Accidents are classified according to the supervising arrangements. A miner, for example, may be injured on his way to and from work, and obviously, whether the accident should be charged to mining, ventilation, haulage, or other department depends on the place and cause of the injury. Again, a man may be removed from his regular class of work to another. Injuries from blasting operations will be found under ventilation for the reason that shot firers and fire bosses are responsible for adequate ventilation as well as shot firing, and safety practices as they relate to blasting are an important part of their duties.

One table showed the number of injuries, time lost, accident rates and percentages by causes for all injuries during the period 1929-1932 at the New Black Diamond mine. Outstanding points of interest under "Preparation and loading" (13 accidents and 450 days) are the accidents from railroad cars (4 accidents and 168 days); under "Haulage and hoisting" (32 accidents and 8,978 days) those from getting off trips while moving (5 accidents and 452 days) and being struck by coal during loading operations underground (2 accidents and 1,882 days); under "Ventilation and light" (9 accidents and 7,675 days) those from being struck by falling material following blasting (5 accidents and 3,138 days); under "Mining" (222 accidents and 38,934 days), being struck in the eyes by flying coal from the pick (21 accidents and 264 days) and by falling roof while in the act of setting timber (30 accidents and 12,780 days). This last cause indicates that proper inspection and testing of the roof is lacking; the excuse of "just getting ready to set a timber" may be sometimes used by the workmen to give a reason. Supervisors are constantly warning the men and discipline is now taking an added significance. In general, slipping and falling are important, as they caused 42 accidents and 6,919 days of lost time. In the 4-year period, underground work accounted for 273 accidents and 55,772 lost days, and surface activities for 24 accidents and 626 lost days.

---

[12] Adams, W. W., The National Safety Competition of 1929: Report of Investigations 3019, Bureau of Mines, 1930, p. 3.

Another table showed the number of injuries and time lost according to labor classification, occupation, and percentage of man-hours of exposure for the labor classification, the features being given in the preceding paragraph. The variable working time makes it of value to consider the man-hours of exposure in employment rather than the average number of men employed in a certain occupation.

The accident frequency and severity for underground employees was 147.6 and 30.2, and for surface employees was 43.4 and 1.1, respectively, for the period 1929-1932. Miners have the greatest frequency rate (192.1) and the labor classification "Ventilation and light" has the greatest severity rate (98.4) as a result of injuries to miners and others caused by being struck by falling material following blasting.

The graphs prepared but not shown here reveal plainly the beneficial results of accident-prevention work. Even with the inclusion of the explosion[13] of 1930 whereby 17 men were killed the accident rate for the State shows a trend downward and the New Black Diamond mine holds an enviable position. The severity for the State as a whole is due to the severity of permanent total disability injuries.

Another table showed the number of injuries by the nature of injury and part of body injured for the period 1929-1932 at the New Black Diamond mine. The result of physical examinations is convincingly shown by the development of only two hernias in this period. The decrease in the number of eye injuries shows the importance of the use of goggles, now required. Two eyes were destroyed and 30 eyes were injured in the period. As a result of accident-prevention work fractures were reduced to 53, including 1 fatal and 2 permanent partial disabilities, entailing a loss of 29,276 days. There were 7 infections in 1929, none in 1930 and 1931, and 3 in 1932. Sprains (ankle and knee) and strains (back, side, and groin) continue, yet are fewer in number; there were 5 sprains in 1929 and 2 in 1932, and 12 strains in 1929 and 2 in 1932.

---

[13] See footnote 5c.

COST OF ACCIDENTS

Compensation benefits are paid for injuries received, and medical care is given at the New Black Diamond mine under regulations governing all mines of the State as prescribed by State law and administered by the State Department of Labor and Industries. It is beyond the scope of this report to discuss the compensation system. The subject as it relates to the mining industry has been discussed in detail in other publications[14, 15] of the Bureau of Mines.

Briefly, Washington's industrial insurance system operates on an exclusive basis. Compensation rates have been based on claim losses per $100 of pay roll, while medical cost rates are based on claim losses per 8-hour man-day of exposure. There is no overhead charge for compensation insurance, as this cost is cared for by appropriation of the State and paid by the general taxpayer. This charge has averaged approximately 7 percent[16] of the premiums paid. The segregated medical-aid fund and no direct cost of overhead or administration to the industry are unique features in the Washington law. The industrial insurance costs as given in this report therefore represent both the pure premium and net total cost to the industry. Medical aid is unlimited and is for all injuries whether compensable or noncompensable; one half the cost is borne by the employee. The man-day rate is fixed for all mines alike, but can be handled by the State or by the individual plant. In practice, each industry functions essentially as a mutual insurance association responsible for its own losses and under State auspices. Rates are based on the class experience and their application is largely controlled by the industry itself. It has been the policy of this industry not to carry any large reserve to cover the cost of catastrophes but to meet such costs, after conference with all concerned, by graduated assessments on the tonnage basis and distributed to each operation alike. Merit credits are given on an equal percentage basis for all plants, irrespective of size of pay roll for accident-prevention work as reflected through surplus over claim losses. That the system has met the catastrophe losses of the class successfully, and there have been several, is testified to by the fact that at the close of 1932 the class had a reserve of approximately $100,000 after paying claim losses for compensation alone of about $3,500,000 during a period of 20 years.

The segregated medical-aid fund on a man-day basis clearly indicates whether costs are increasing or decreasing. It also places the charges equitably where they belong, permits a careful scrutiny of medical costs, and eliminates an indicated weakness of the indivisible premium of "robbing Peter to pay Paul." Further, it is consistent with accident rates, is reconcilable with man-hours of exposure, is not affected by fluctuating wage scales, controls effectively the anticipated earned premiums, and

---

[14] See footnote 4.

[15] Ash, S. H., Accident Experience and Cost of Accidents in Washington Metal Mines and Quarries: Tech. Paper 514, Bureau of Mines, 1932, 35 pp.

[16] See footnote 15.

eliminates the necessity of assessments to compensate diminished premium income. Where medical fees are fixed, a just and equitable charge is applied to all plants alike. The same reasoning applied to the compensation item will go a long way toward eliminating much of the misunderstanding incident to assessment on the pay-roll basis and will not penalize the operator who pays higher wages for the same man-hours of exposure under the same conditions and same class of work. It will tend to reconcile accident rates with accident costs and will permit the indicated severity of accidents to lead the way to investigation and analysis of the costs and elimination of various classes of injuries.

The unique feature insofar as United States compensation systems are concerned was interpreted into law by the State legislature of Washington in March, 1933. By this legislation, contribution to the accident fund (compensation item) was changed from the pay-roll to the man-hour basis. (H.B. 435.)

During the period 1927-1931 the New Black Diamond mine produced 11 percent of the State total coal tonnage and worked 11.6 percent of the total time for all State mines. The Black Diamond had 3 fatalities and produced 436,456 tons per fatality, whereas the respective figures for the State were 73 killed and 162,616 tons produced per fatality. The mine's showing for the period 1929-1932 is much better and the State's is about the same. The net compensation cost to the Black Diamond from 1927 through 1931 was $111,167, or $22,233 a year. This included medical cost and special assessments, also merit rating credits of the last three years which totaled $9,591.

Calculated trends as shown in the graphs prepared but not reproduced here definitely indicate that safety work pays as it relates to accident costs. The variance of the three bases mentioned shows the advisability of their consideration. In the following listings the trends are noted as "upward" or "downward" for the periods indicated:

Trends of industrial insurance costs in Washington and New Black Diamond mine

State of Washington, 1927-1931		New Black Diamond mine 1927-1931	New Black Diamond mine 1928-1931
Pay-roll basis:			
Compensation	Upward	Downward	Downward
Medical	Upward	Downward	Downward
Industrial insurance	Upward	Downward	Downward
Man-hour basis:			
Compensation	Upward	Upward	Downward
Medical	Downward	Downward	Downward
Industrial insurance	Upward	Upward	Downward
Tonnage basis:			
Compensation	Downward	Downward	Downward
Medical	Downward	Downward	Downward
Industrial insurance	Downward	Downward	Downward

The difference in the effect of the pay-roll and man-day basis is at once apparent in noting the medical cost trend which is on a man-day basis for the class as a whole and therefore is the same both for the mine and for the State. It will be observed that the medical costs per man-day of exposure are downward, which also reflects Washington's improvement in this item of industrial insurance cost. This probably is due to two things: (1) The system of more or less general first-aid training (76 percent of the State's mine employees are so trained); and (2) the coordinatod effort of the employees, workmen, and the State through the medical system in effect. Referring to the pay-roll basis for medical trends, it will be observed that the State trend was upward while the New Black Diamond was downward. This was due entirely to a decreasing man-day wage for the State and an increasing one for New Black Diamond. The increasing average man-day wage for New Black Diamond is accounted for by the fact that efficiency in mine operation has increased through the reduction of forces on dead work, development, maintenance, and efficient planning; this increased the production per man-day from 2.52 tons in 1927 to 3.41 tons in 1932, whereas the whole State remained practically stationary for that period -- 3.35 tons in 1927 and 3.46 tons in 1932. The reduction of force on day work other than breaking coal obviously raises the production per man-day, as there are more men in proportion directly producing coal. For this reason the production per man-day could increase and there still not be an increase in the production per miner-day; however, this has also increased on account of the working of more productive areas. Being on a contract basis, the average wage level of the miners therefore increased; this fact, coupled with idle time and the steady employment of a nominal force of supervisors on a wage level slightly higher than day labor, has tended to raise the wage level in this mine.

Mechanization has played no part in increasing the tonnage per man-day at this mine, and for this reason the tonnage basis of comparison is significant as to accident-prevention work and efficiency with the same mining methods.

Many mines measure the results of safety work by the reduction in the number of accidents rather than by reduction (1) in units of production per accident; (2) number of man-hours of exposure per accident (frequency and severity); and (3) cost of injuries per $100 of pay roll, per man-hour of exposure, and per unit of production.

The cost per man-hour of exposure is the only basis that does not vary except with variation in the injury rates and cost schedules awarded for injuries. On this basis the trend of accident costs for the State as a whole is consistent with the severity rate. For the period 1927-1931 the compensation cost trend was upward 4.74 percent, the medical cost trend was downward 7.53 percent, and the industrial insurance (total) cost was upward 2.57 percent. The upward total trend, although relatively slight, is due entirely to the compensation costs per man-day of permanent total disability injuries, the trend increasing 87.5 percent over the 5-year period; there is little or no malingering in this type of injury and costs can be reduced only through accident-prevention work. Serious nonfatal accidents in times past have played a similar role at the New Black Diamond; in many cases they are more costly in dollars than fatalities.

CONCLUSION

To the workmen the frequency and severity of accidents are the all-important factors; to the employer, although these factors are also paramount, safety work is being economically successful only when it reduces the cost per unit of production. The coal-mining industry of Washington for the 5-year period 1927-1931 has reduced its industrial insurance costs (compensation and medical) per unit of production. The New Black Diamond mine for the period 1928-1931 has reduced its accident costs on all bases. Accident-prevention work, not only in the Black Diamond mine, but also in the coal-mining industry of Washington, is therefore successfully accomplishing its purpose.

For compensation and medical benefits alone, coal-mine accidents since 1913 in Washington have cost the employers some $4,086,000 and the employees $591,000; the administration of these benefits has cost the State some $327,000; the total cost therefore has been approximately $5,000,000. During this 20-year period (1913-1933) 475 lives were lost in this relatively small group of coal mines. Truly the prevention of accidents is a mutual problem, and by concerted effort the industry apparently is advancing well on the way toward paying dividends of various kinds through the elimination of economic waste and misery. In this the Black Diamond mine by its excellent safety performance in recent years, but especially in 1931 and 1932, is setting the pace and is showing that even in pitching beds, coal mining can be done with relative safety.